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STUDY TITLE: Ecological Characterization of the Mississippi Delta Plain Region

REPORT TITLE: Ecological Models of the Mississippi Deltaic Plain Region: Data Collection and Presentation

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BACKGROUND: Increasing human pressure on coastal ecological resources has resulted in the need for a more thorough understanding of ecosystem interrelationships. The ultimate management goal is a comprehensive understanding of coastal systems and ability to utilize and preserve coastal ecological resources more effectively. Effective management depends upon knowledge of functional interdependencies, both within coastal ecological systems and between human and natural systems. This report attempts to document current level of knowledge of ecological interdependencies in the Mississippi Deltaic Plain Region (MDPR) of coastal Louisiana and Mississippi. Funding was provided by the Bureau of Land Management and the work effort was completed through a Memorandum of Understanding with the U.S. Fish and Wildlife Service.

OBJECTIVES: (1) To develop ecosystem models and a narrative report summarizing existing data for the MDPR; and (2) to integrate information on the ecology, hydrology, climatology, and socioeconomics of the 20 ecological and economic habitats and 7 hydrological units into which the MDPR has been divided.

DESCRIPTION: A general framework for ecological data was constructed to summarize existing information, direct report emphasis, and point out areas in need of further research. The framework categorized information according to its functional significance and served as a compendium of data and as a "model" of structure of involved ecosystems. The framework was hierarchical, as data at various levels of space and time resolution could be conveniently and efficiently stored and collected, and was open ended so that additional data could be added as available. The three levels considered in order of increasing size were habitats, hydrological units, and the entire MDPR. These levels were hierarchical, in that habitats made up hydrological units and these formed the MDPR. For purposes of this study, 20 habitat units were defined. The 20 types were aggregations of more than 100 habitat types that were mapped in the MDPR. The region was divided into seven hydrological units, each which had a characteristic habitat distribution that was determined by both external influences and internal interactions among habitats.

The project developed and presented quantitative information on flows of matter and energy in MDPR ecological systems. Thousands of measurements made by hundreds of independent researchers at different times, using different techniques, and different accuracy and completeness levels were synthesized and recorded. The measurements varied in degree of precision and applicability to the project. Detailed notes supporting and qualifying each of the calculations and estimates used in the study were included after each detailed habitat model.

SIGNIFICANT CONCLUSIONS: Any attempt to codify, characterize, or quantify complex workings of natural and economic systems necessarily involves approximations. In this study, various degrees of approximation were necessary because of the wide array of information sources employed and the varying quality, coverage, and precision of the assembled data. Most of the available ecological data was site-specific, and oriented toward a particular habitat. Therefore, habitat level data were generally of the highest quality. Very little direct information on transfers between habitats was available. The hydrologic unit level information, therefore, was much less precise. Certain habitats have been studied more intensively than others, and this is reflected in the level of detail and precision achieved in the habitat models. The uneven quality of information was a fundamental recurring problem throughout this and other studies that have attempted a quantitative synthesis from a wide variety of data sources. Sifting through long descriptions of detailed calculations was required to form an opinion about the relative quality of the estimates. A system to communicate a summary assessment of the degree of precision with each estimate would be useful.

STUDY RESULTS: The regional model illustrated the primary forcing functions that drive the region (i.e., external economy, the Mississippi and several other coastal rivers, the outer Gulf system, and atmospheric inputs). The model also illustrated major interconnections among basins and their forcing functions. The specific regional model configuration showed the present state of the area, the result of long-term geological processes; alluvial (depositional) and marine (erosional) processes in combination with

a gradual rise in sea level. Because of periodic switches in the course of the major distributory of the Mississippi River (about once every 500 years), the areas of different basins have waxed and waned.

The main economy has greatly supported maintenance of the present course of the Mississippi River through flood control and navigational projects on it and the Atchafalaya River. The U.S. Army Corps of Engineers is committed to these programs which require increasing monetary inputs. Only 30% of the Mississippi River flow is currently allowed to enter the Atchafalaya River, despite the natural tendency of the Atchafalaya to capture a greater percentage. In addition, a massive flood control program was instituted for the entire lower Mississippi system, following the disastrous 1927 flood. This program includes continuous man-made levees along the river and a series of dams in the upper tributaries. Navigation is facilitated by artificially dredged deep water channels from the Gulf of Mexico upstream to Baton Rouge. As a result of these management programs, the MDPR is experiencing a net sediment deficit, presumably for the first time in its 4,500-year history. This deficit is due to a combination of river containment between the levee banks, discharge of the major sediment load off the continental shelf, and sediment trapping by man-made dams along the tributaries of the upper Mississippi.

A major shift in sediment load from the eastern to the western end of the MDPR is occurring. The new Atchafalaya Delta system is building rapidly, and freshwater marsh habitat within the basin is increasing. In most other basins, wetland habitats are eroding into estuarine open water habitats at an accelerating rate. The only basins that normally receive direct water and sediment inputs from the Mississippi River are the Atchafalaya and Mississippi River Delta basins. Mississippi River sediment inputs to other basins occur indirectly through marine processes (erosion and redeposition). The Pontchartrain hydrologic unit is exceptional in that during extreme flood stages, the Bonnet Carre Spillway is opened, introducing significant quantities of sediment and freshwater into western Lake Pontchartrain. Some of this input, in turn, flows into the Mississippi Sound basin via Lake Borgne.

Exchanges between hydrologic units in the MDPR include such diverse commodities as freshwater, sediment, migrating animals, agricultural and manufactured goods, and airborne and waterborne waste products. The U.S. economy receives major supplies of fossil fuels, refined petroleum, and petrochemicals from the MDPR. It also receives other mineral resources such as sulfur and salt, agricultural commodities such as refined sugar and lumber, and the largest fishery harvest in the country.

Atmospheric inputs to the MDPR symbolize the subtropical climate and high rainfall that characterize the area. This forcing function, along with tidal and other marine influences from the outer Gulf, drives high rates of primary and secondary production by coastal organisms. This production results in a high rate of organic deposition to the sediments, which normally allows undisturbed wetland habitats to keep pace with the slowly rising sea level. Atmospheric inputs also strongly affect the regional agricultural system in terms of the choice of cash crops. Residential energy consumption and a variety of

cultural practices are also dictated by climate. These in turn strongly affect economic activities and the type of coastal zone management decisions that are made.

STUDY PRODUCT: Costanza, R., C. Neill, S. G. Leibowitz, J. R. Fruci, L. M. Bahr, Jr., and J. W. Day, Jr. 1983. Ecological Models of the Mississippi Deltaic Plain Region: Data Collection and Presentation. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. NTIS No. PB84-182864. FWS/OBS-82/68. Contract No. 14-12-0001-29085. 362 pp.

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